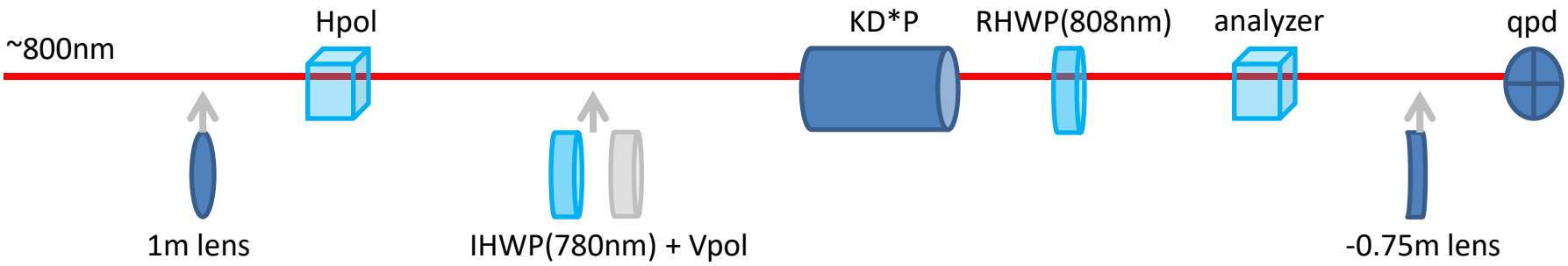
Spot-Size Reduction

4/5/2017

UVa Results – Reducing Spot-size Helps



- w_{pc}= 1.35mmX,1.46mmY, w_{qpd}=1.43mmX,1.58mmY
  - 4θ terms ~ 1.3-1.5umX, 0.76-1.1umY
- w_{pc}~0.324mmX,0.341mmY,w_{qpd}= 0.886mmX,0.891mmY ~ **7x**
  - 4θ terms (NOT realigned) ~ 2.2-3.1umX, 2.5-4.3umY
  - 4θ terms(aligned) ~ 0.29-0.27umX,0.24um-0.09umY ~ 5.2x
- w_{pc}= 0.324mmX,0.341mmY,w_{qpd}= 2.06mmX,1.907mmY ~ **3x**
  - 4θ terms ~ 0.47-0.54umX,0.33-0.36umY ~ 2.7x

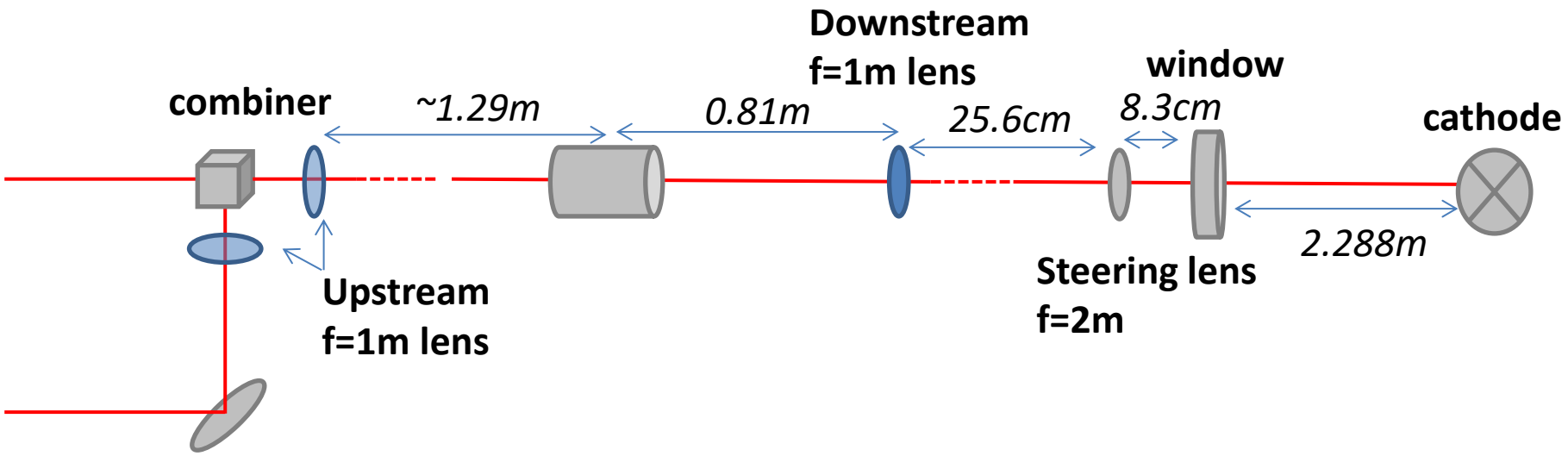
4θ terms ~ wpc * wqpd

3 scenarios (Injector Table)

1. Now: w_{pc}=1.9mm, w_c=1.1mm
2. Upstream 1m lens (z=-1.29m): w_{pc}=0.53mm, w_c=0.85mm
3. Up+Downstream(z=0.81) 1m lenses: w_{pc}=0.53, w_c=1.1mm
4. *A 1m lens 0.2m after the Pockels cell, would keep the wpc the same=1.9mm and enlarge the wc from 1.1mm to 2.05mm (so 4sigma~4mm).*

Scenario #2 has a ~20% spot size reduction on the cathode
Scenario #3 goes through a focus after the vacuum window

Layout (Conceptual)



- May have Upstream Lens before or after combiner (either affecting all Halls or affecting only Hall A)
- Upstream lens permanently installed
- May keep downstream lens installed or not (20% spot size difference on cathode)

Predictions
(not including vacuum window or 2θ terms)

- NOW: model UVa KD*P, Jlab spotsizes
  - ~100nm offsets, 10-40nm 4θ terms
  - Measure bpm0I01 first after cathode 25-45nm 4θ
- 1m lens upstream: model UVa KD*P, Jlab predicted spotsizes
  - 20-30nm offsets, <10nm 4θ terms
- +Photocathode Rotation
  - (<5nm offsets & 4θ terms prediction)
  - Really beneficial for the vacuum window birefringence gradient which is not modeled here…but is important

Resources Needed

- 2 f=1m lenses (we have 2 at UVa, but for permanent Jlab installation, so maybe order lenses for the week after next)
- 2 4-axis lens mounts (pitch,yaw, X,Y)
- Control over the helicity board
- 3-5mW of Hall A laser for alignment (CW or pulsed, either is fine)
- HallA Electron beam >20uA (70uA is good) going up to at least FC1
- (Conditions of injector beamline should be as if accelerator were going to run 70uA of 1GeV beam, or 150uA of 2GeV beam)

- *Walk-through of injector laser for Amali (M)*
- *Someone in control room who can change beam current, turn on/off autogaining on bpms (M morn., T even., W morn., W even., Th morn., Fri morn.)*
- *Electron beam (M morn, M aft., T even., W, Th 3x, F)*
- *Access to injector laser room (M even., T, W aft.,Th 3x, F morn.)*
- *Someone who can get the laser to give us 3-5mW of Hall A laser beam(M even., T, W aft.,Th 3x, F morn.)*
- *Someone who can help us rotate the photocathode Angle (Th 3x, F morn)*

Plan

- Day1 - benchmarking, bpm/bcm calibration, RHWP scans (#1), QPD laser setup
- Day2 - QPD setup, camera measurements, lens alignment, PC realignment, maybe RHWP scans(#2)
- Day3 – bpm/bcm calibration, RHWP scans(#2), downstream lens insertion, camera measurements, bpm/bcm calibration, RHWP scans(#3)
- Day4 - Photocathode rotation, bpm/bcm calibration, RHWP scan (repeat 3X)
- Day5 – Final photocathode angle selection, bpm/bcm calibration, RHWP scan (final)

Day1

- Day1 benchmarking
- **Morning – bcm/bpm calibration**
- *Need someone in control room who can change beam current, turn on/off autogaining on bpms*
- HallA Electron beam >20uA (70uA is good) going up to at least FC1
- BCM/BPM calibration scan - 5uA steps of current up to max current, auto gaining on injector bpms off
- Autogaining of injector bpms back on
- **Afternoon – RHWP scans**
- 4 RHWP scans (IHWP in/out PITA 0/ PITA non-zero) – 2 hours
- Tweak Pockels cell translation – 1 hour
- Repeat 4 RHWP scans (IHWP in/out PITA 0/ PITA non-zero) – 2 hours
- **Evening –laser QPD setup**
- *Need Access to injector laser room*
- *Need someone who can get the laser to give us 3-5mW of Hall A laser beam*
- Setup pick off to QPD

Day 2

- Day 2 upstream lens insertion and PC re-alignment
- **Morning – QPD setup, camera measurements, lens alignment**
- *Need Access to injector laser room*
- *Need someone who can get the laser to give us 3-5mW of Hall A laser beam*
- 3-5mW Hall A laser (CW or pulsed, either is fine)
- Finish Setup of QPD pickoff / calibration
- *CHECK PC alignment with no analyzer (steering) and Aq in S2 (do PITA scan to make sure in S2)*
- Get spiricon measure of spot size at cathode
- Repeat measure of spot size at pockels cell (will bring our own spiricon for this)
- Insert 1m lens upstream of Pockels Cell at predetermined z-position **z=…**
- measure of spot size at pockels cell (will bring our own spiricon for this)
- Measure divergence of laser at Pockels cell
- Measure spiricon spot size at cathode
- *Measure spot size at vacuum window(if possible)*
- Measure spot size at QPD
- **Afternoon – PC realignment**
- Calibrate QPD
- Check PC alignment starting point– S1, S2, no anal, RHWP scan
- Align Pockels cell
- **Evening – PC realignment (maybe RHWP scans)**
- *PC alignment*

Day 3

- Day 3 PC -RHWP scans + downstream lens insertion
- **Morning – RHWP scans**
- *Need someone in control room who can change beam current, turn on/off autogaining on bpms*
- HallA Electron beam >20uA (70uA is good) going up to at least FC1
- BCM/BPM calibration scan - 5uA steps of current up to max current, auto gaining on injector bpms off
- Autogaining of injector bpms back on
- 4 RHWP scans (IHWP in/out PITA 0/ PITA non-zero) – 2-4 hours
- **Afternoon – downstream lens insertion + camera measurements**
- *Need Access to injector laser room*
- *Need someone who can get the laser to give us 3-5mW of Hall A laser beam*
- 3-5mW Hall A laser (CW or pulsed, either is fine)
- Insert 1m lens downstream of Pockels Cell at predetermined z-position **z=…**
- Measure spiricon spot size at cathode
- *Measure spot size at vacuum window (if possible)*
- **Evening – bpm/bcm calibration + RHWP scans**
- *Need someone in control room who can change beam current, turn on*
- HallA Electron beam >20uA (70uA is good) going up to at least FC1
- 4 RHWP scans (IHWP in/out PITA 0/ PITA non-zero) – 2-4 hours
- **decide to keep downstream lens or remove + RHWP scans**
- *Need Access to injector laser room*
- Remove 1m lens downstream of PC (if decided)

Day 4

- Day 4 Photocathode rotation
- **Morning**
- *Need Access to injector room*
- *Need someone who can help us rotate the photocathode Angle #2*
- HallA Electron beam >20uA (70uA is good) going up to at least FC1
- *Need someone in control room who can change beam current, turn on/off autogaining on bpms*
- HallA Electron beam >20uA (70uA is good) going up to at least FC1
- BCM/BPM calibration scan - 5uA steps of current up to max current, auto gaining on injector bpms off
- Autogaining of injector bpms back on
- 4 RHWP scans (IHWP in/out PITA 0/ PITA non-zero) – 2-4 hours
- **Afternoon**
- *Need Access to injector room*
- *Need someone who can help us rotate the photocathode Angle #3*
- HallA Electron beam >20uA (70uA is good) going up to at least FC1
- 4 RHWP scans (IHWP in/out PITA 0/ PITA non-zero) – 2-4 hours
- **Evening**
- *Need Access to injector room*
- *Need someone who can help us rotate the photocathode Angle #4*
- HallA Electron beam >20uA (70uA is good) going up to at least FC1
- 4 RHWP scans (IHWP in/out PITA 0/ PITA non-zero) – 2-4 hours

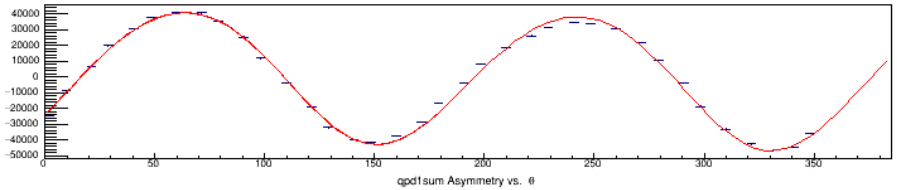
Day 5

- Day 5 Photocathode rotation final
- **Morning/Afternoon/Evening**
- *Need Access to injector room*
- *Need someone who can help us rotate the photocathode FINAL ANGLE*
- HallA Electron beam >20uA (70uA is good) going up to at least FC1
- 4 RHWP scans (IHWP in/out PITA 0/ PITA non-zero) – 2-4 hours
- PC translation to optimize
- 4 RHWP scans (IHWP in/out PITA 0/ PITA non-zero) – 2-4 hours

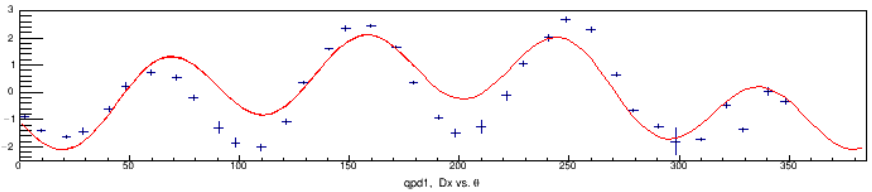
w_{pc}= 1.35mmX,1.46mmY,w_{qpd}=1.43mmX,1.58mmY

UVA data

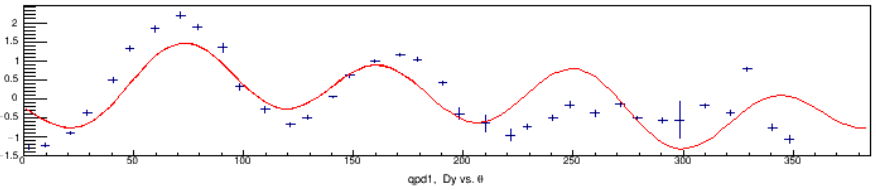
RHWP scan, Run 3928, IHWP OUT, qpd1, PITA =0



Aq = -958.35 + -2338.94 sin (1x+ 152.78) + -42100.45 sin (2x+ 146.72) + 1898.59 sin (4x+ 45.67)

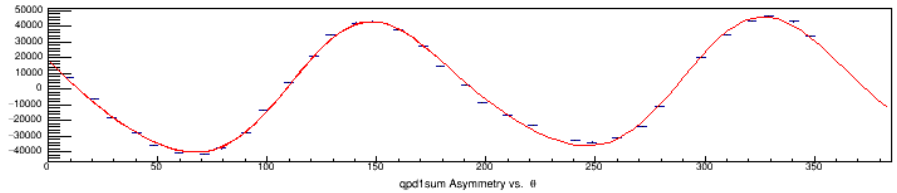


Dx = 0.10 + -1.01 sin (x*1+ 93.11) + -0.25 sin (2x+ 146.25) + -1.30 sin (4x+ 2.91)

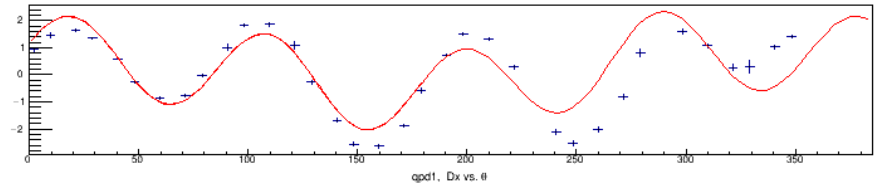


Dy = 0.04 + -0.53 sin (x*1+ 148.36) + -0.33 sin (2x+ 136.20) + 0.76 sin (4x+ 162.97)

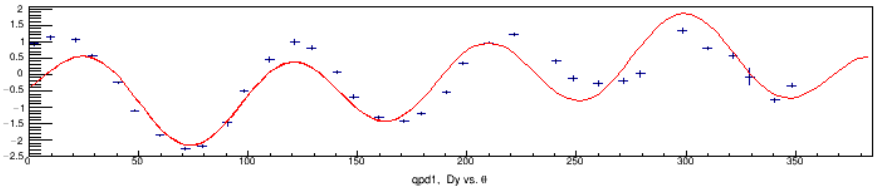
RHWP scan, Run 3929, IHWP IN, qpd1, PITA =0



Aq = 378.71 + 2431.11 sin (1x+ 170.57) + 40793.87 sin (2x+ 148.38) + -4318.21 sin (4x+ 76.52)



Dx = 0.23 + 0.73 sin (x*1+ 105.34) + -0.18 sin (2x+ 63.61) + 1.50 sin (4x+ 15.66)



Dy = -0.17 + 0.78 sin (x*1+ 168.29) + 0.28 sin (2x+ 164.66) + -1.10 sin (4x+ 155.40)

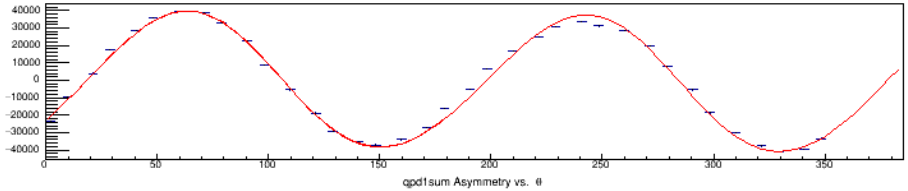
4θ terms

1.3um(IHWPout)/1.5um(IHWPin)X, 0.76um(IHWPout)/1.1um(IHWPin)Y

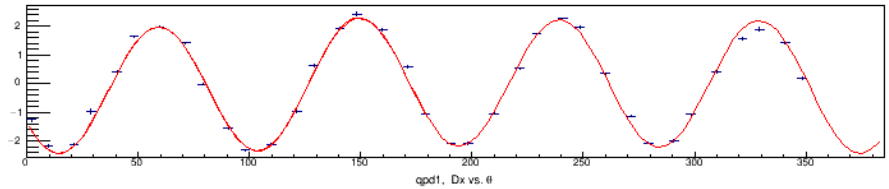
wpcx<=0.324mmX,0.341mmY wqpdx~0.886mmX,~0.891mmY
PC NOT realigned, angle=(1mrad yaw,6mrad pitch)

UVA data

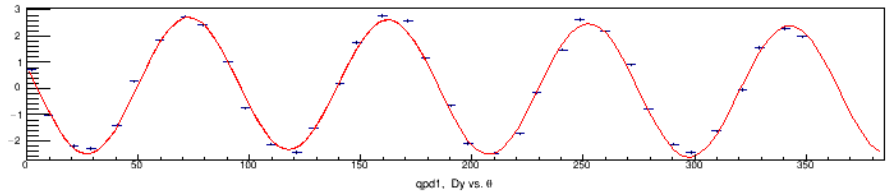
RHWP scan, Run 3938, IHWP OUT, qpd1, PITA =0



Aq = -1193.40 + -1605.97 sin (1x+ 154.47) + -39045.82 sin (2x+ 146.64) + 1345.18 sin (4x+ 149.34)

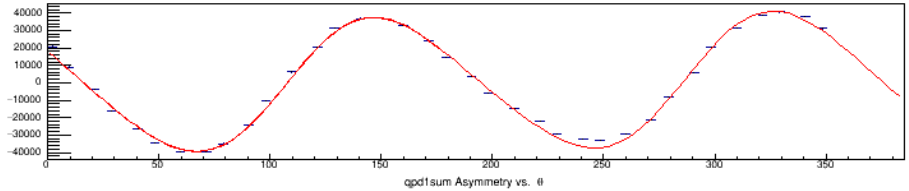


Dx = -0.06 + -0.13 sin (x*1+ 51.00) + 0.07 sin (2x+ 158.24) + -2.23 sin (4x+ 33.65) -Aq*-0.00016880

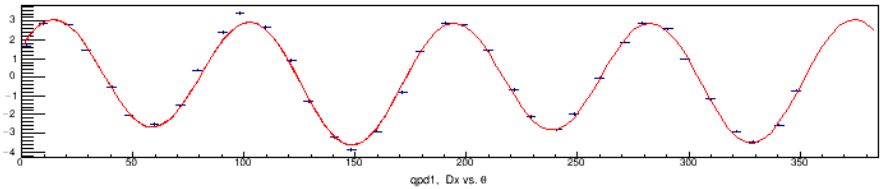


Dy = 0.03 + -0.16 sin (x*1+ 154.05) + -0.05 sin (2x+ 117.39) + 2.53 sin (4x+ 160.21) -Aq*-0.00003150

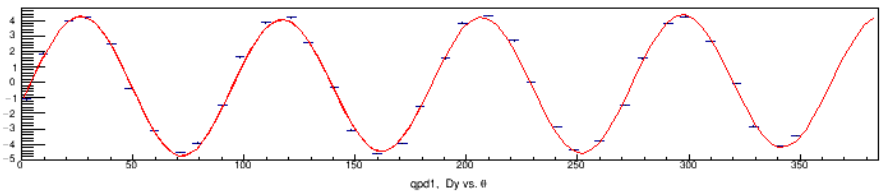
RHWP scan, Run 3939, IHWP IN, qpd1, PITA =0



Aq = -38.28 + 1904.43 sin (1x+ 144.99) + 38184.48 sin (2x+ 147.64) + -3576.49 sin (4x+ 105.14)



Dx = -0.10 + 0.10 sin (x*1+ 66.30) + -0.41 sin (2x+ 158.92) + 3.07 sin (4x+ 36.20) -Aq*-0.00016880



Dy = -0.13 + 0.16 sin (x*1+ 138.86) + 0.17 sin (2x+ 124.77) + -4.34 sin (4x+ 162.36) -Aq*-0.00003150

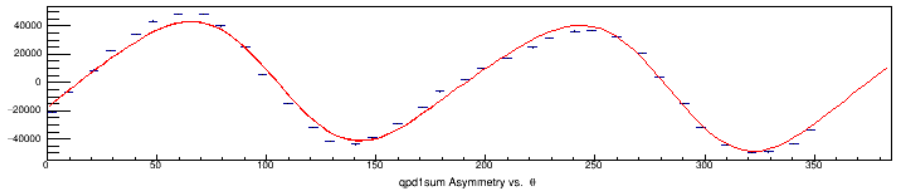
4θ terms

2.2um(IHWPout)/3.1um(IHWPin)X, 2.5um(IHWPout)/4.3um(IHWPin)Y

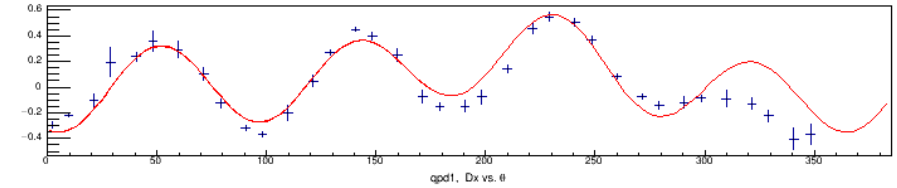
wpcx<=0.324mmX,0.341mmY wqpdx~0.886mmX,~0.891mmY
PC realigned, angle = (-0.3mrad yaw, 5.5mrad pitch)

UVA data

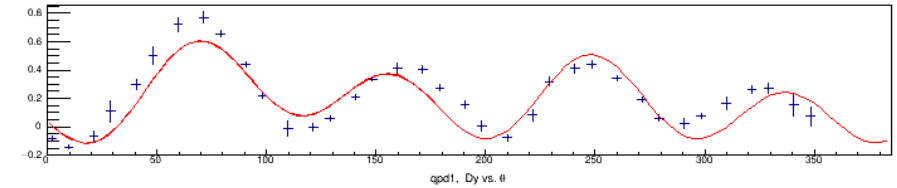
RHWP scan, Run 3955, IHWP OUT, qpd1, PITA =13



Aq = -616.04 + -3763.07 sin (1x+ 136.19) + -42401.76 sin (2x+ 154.13) + 4843.15 sin (4x+ 116.31)

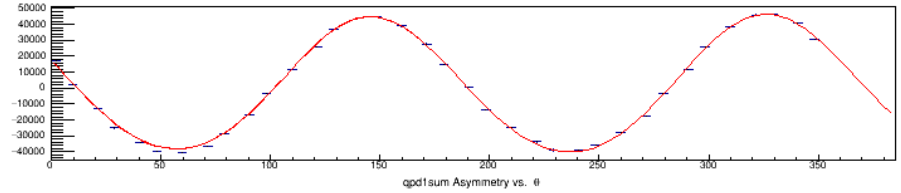


Dx = 0.07 + -0.15 sin (x*1+ 72.17) + 0.08 sin (2x+ 0.42) + -0.29 sin (4x+ 63.97) -Aq*0.00000015

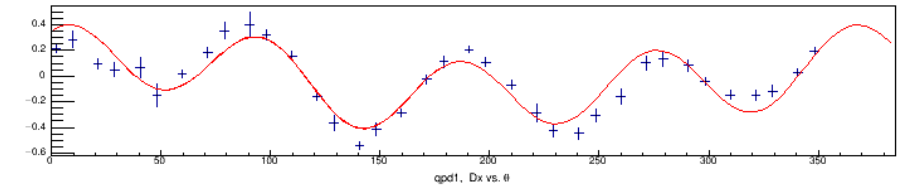


Dy = 0.19 + -0.08 sin (x*1+ 148.76) + -0.13 sin (2x+ 113.67) + 0.24 sin (4x+ 179.40) -Aq*-0.00001758

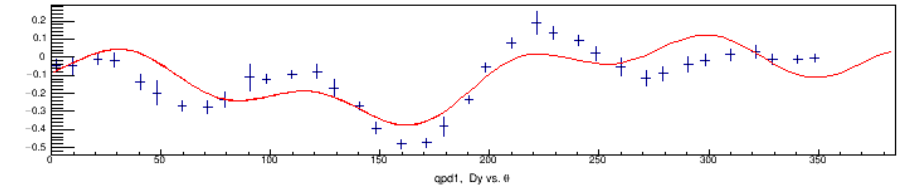
RHWP scan, Run 3959, IHWP IN, qpd1, PITA =0



Aq = 1351.67 + 1242.14 sin (1x+ 71.54) + 42276.28 sin (2x+ 157.28) + -2003.40 sin (4x+ 53.62)



Dx = -0.02 + 0.15 sin (x*1+ 64.62) + -0.05 sin (2x+ 171.11) + 0.27 sin (4x+ 65.99) -Aq*0.00000363



Dy = -0.10 + 0.16 sin (x*1+ 139.12) + -0.06 sin (2x+ 143.07) + -0.09 sin (4x+ 141.54) -Aq*-0.00001645

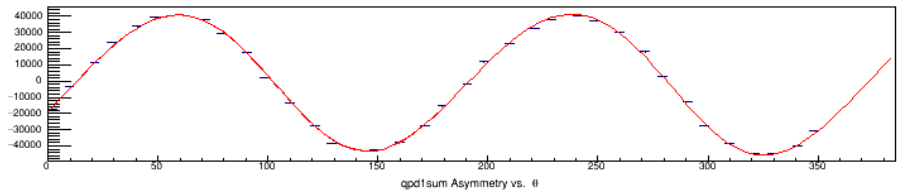
4θ terms

0.29um(IHWPout)/0.27um(IHWPin)X, 0.24um(IHWPout)/0.09um(IHWPin)Y

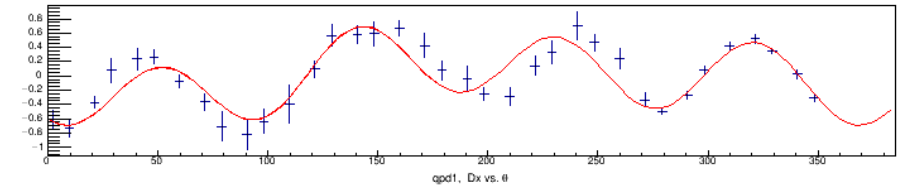
wpcx<=0.324mmX,0.341mmY wqpdx~2.06mmX,~1.907mmY
PC realigned, angle = (-0.3mrad yaw, 5.5mrad pitch)

UVA data

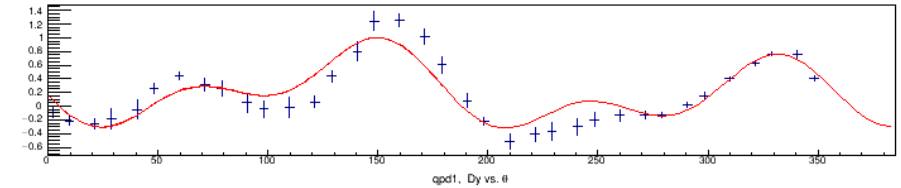
RHWP scan, Run 3966, IHWP OUT, qpd1, PITA =0



Aq = -1124.01 + -1317.14 sin (1x+ 110.43) + -42666.97 sin (2x+ 156.04) + -1319.43 sin (4x+ 285.86)

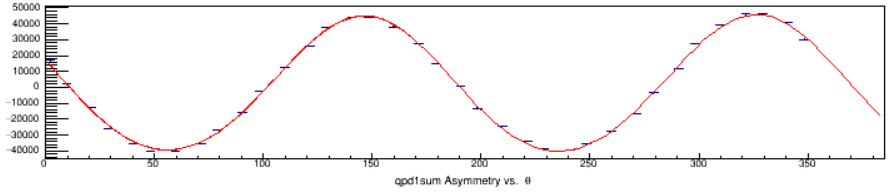


Dx = -0.02 + -0.24 sin (x*1+ 65.68) + 0.13 sin (2x+ 151.02) + -0.47 sin (4x+ 64.36) -Aq*0.00000014

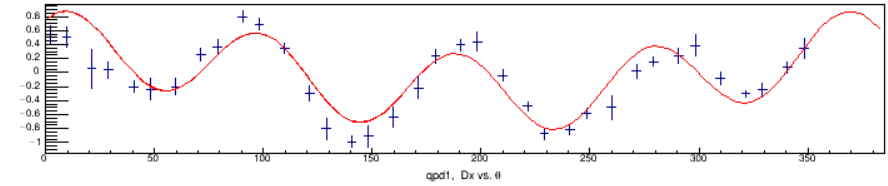


Dy = 0.21 + -0.15 sin (x*1+ 156.81) + 0.39 sin (2x+ 167.80) + -0.31 sin (4x+ 15.08) -Aq*-0.00002046

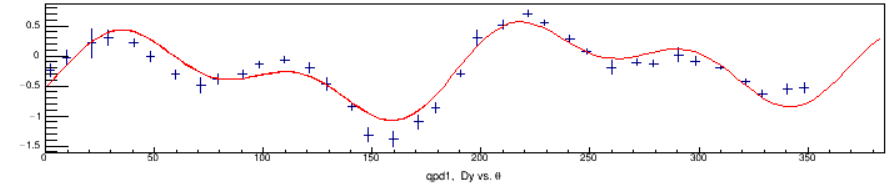
RHWP scan, Run 3967, IHWP IN, qpd1, PITA =0



Aq = 1125.97 + 578.45 sin (1x+ 85.91) + 42608.65 sin (2x+ 157.78) + -1773.13 sin (4x+ 36.94)



Dx = -0.02 + 0.32 sin (x*1+ 63.93) + 0.06 sin (2x+ 55.77) + 0.54 sin (4x+ 55.84) -Aq*0.00000014



Dy = -0.20 + 0.19 sin (x*1+ 163.99) + -0.48 sin (2x+ 157.50) + -0.36 sin (4x+ 149.25) -Aq*-0.00002046

4θ terms

0.47um(IHWPout)/0.54um(IHWPin)X, 0.33um(IHWPout)/0.36um(IHWPin)Y